COMMANDING OFFICER
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ERRATA #1 07 December 1993

Specific Instructions and Errata for
Training Manual

NEETS MODULE 6, NAVEDTRA B72-06-00-92
INTRODUCTION TO ELECTRONIC EMISSION, TUBES, AND POWER SUPPLIES

1. This errata is issued to correct technical and typographical errors in the original printing of this manual. Make the following changes as directed prior to starting the course. Record the installation of this errata on the inside front cover of the training manual.

2. Page 1-5, left column, 1st paragraph, last sentence; change "ammeter" to "voltmeter."

3. Page 1-14, figure 1-15, view (A); change E_{bb} potential from "200V" to "300V."

4. Page 1-18, left column; delete the 2nd paragraph beginning "Tube biasing is very important."

5. Page 1-18, bottom, answer block, A14; delete 2nd sentence.

6. Page 1-21; staple new page 1-21 over old.

7. Page 1-22; staple new page 1-22 over old.

8. Page 1-29, left and right columns; change the following equations as indicated:

from	to
$E = (2 \times 100 \text{ volts}$	$E = 2 \times 100 \text{ volts}$
$Gain = 100 \text{ volts}$	$Gain = 100$
$Gain = \dfrac{200 \text{ volts}}{2 \text{ volts}}$	$Gain = \dfrac{100 \text{ volts}}{2 \text{ volts}}$

9. Page 1-29, right column, 4th paragraph, 13th line; change "(Eb)" to "(E_p)."

10. Page 1-30, left column; change Tube 2 equation to read:

$$m = m \quad x \quad \frac{D\ E_p}{D\ E_g}$$

11. Page 1-30, left column, bottom; change equation to read:

$$gm = \frac{DI_p}{DE_g}$$

12. Page 2-10, right column, last paragraph, next to last sentence; change "(…hugh-plate current)" to "(…high-plate current)."

13. Page 2-14, left column, 23rd line; replace "…electrostatic field between the grid and the cathode…" with "…direction of cathode emitted electron repulsion,…"

14. Page 3-2, figure 3-2 and page 3-38: change *RECTIFIER block* to read "BRIDGE" vice "FULL-WAVE."

15. Page 3-10, bottom of right column; change equation to read:

$$X_L = 2\pi fL$$

16. Page 3-18, right column, last sentence; replace "…you will have a total resistance of 258 ohms." with "…you will have an equivalent impedance of 265 ohms."

17. Page 3-18, bottom of right column; replace existing formula with:

$$Z = \frac{R \ x \ X_C}{\sqrt{(R^2 + X_C{}^2)}}$$

18. Page 3-19, figure 3-34; change "Z = 258 " to read "Z = 265 "

19. Page 3-19, left column, 2nd paragraph, 2nd sentence; Change "…an infinite () impedance…" to read "…an infinite ( ) impedance…".

20. Page 3-19, right column; change the equation as indicated:

from	*to*
$X_c = \frac{(1)(10_6)}{7536}$	$X_c = \frac{(1)(10^6)}{7536}$

21. Page 3-20, left column, *Q*26.; replace question with, "If the inductance of a choke-input filter is increased, will the input ripple voltage amplitude (E_I) increase or decrease?"

22. Page 3-22, right column, last complete sentence; change to read "…voltage remains almost constant."

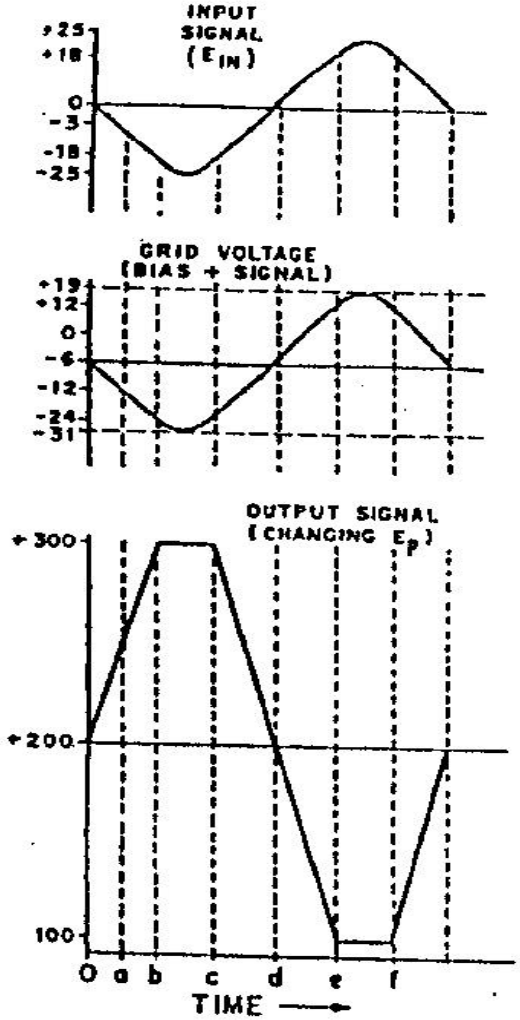
23. Page 3-25, left column, *Q34.;* change "f a power supply…" to read "If a power supply…"

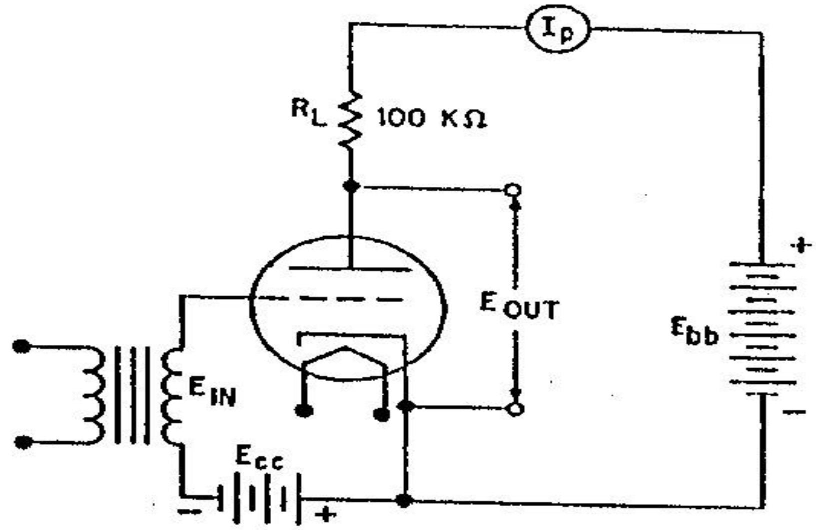
24. Page 3-26, right column, lst paragraph, 11th line; change "across" to "through."

25. Page 3-26, right column, 2nd paragraph, 4th and 10th lines; change "across" to "through."

26. Page 3-26, answer block; change A34. to read "33%" vice "25%."

27. Page 3-27, left column, 1st line; change "across" to "through."





VOLTAGE TABLE	
EIN INPUT SIGNAL	50 VOLTS PEAK TO PEAK
Ebb PLATE SUPPLY	+300 VOLTS D.C.
Ecc BIAS SUPPLY	-6 VOLTS D.C.
EOUT OUTPUT SIGNAL	200 VOLTS PEAK TO PEAK
Ep AT CUTOFF	+300 VOLTS D.C.
Ep AT SATURATION	+100 VOLTS D.C.

Figure 1-20.—Overdriven triode.

current which, in turn, reduces the voltage drop across R_L. The voltage between cathode and the plate is thereby increased. You can see these relationships by following time "a" through the three waveforms.

Now, let's assume that this particular triode cuts plate current flow off when the grid reaches -24 volts. This point is reached at time b when EIN is -18 and the bias is -6 (-18 and -6 = -24). Plate current remains cut off for as long as the grid is at -24 volts or greater.

With zero current flowing in the plate circuit, there is no voltage drop across R_L. The entire plate-supply voltage, E_{bb} (300 volts), appears as plate voltage between the cathode and the plate. This is shown at time b in the output signal waveform. Between time b and time c, the grid voltage is greater than -24 volts. The plate current remains cutoff, and the plate voltage remains at +300. The output waveform between time b and time c cannot follow the input because the plate voltage cannot increase above +300 volts. The output waveform is "flattopped." This condition is known as AMPLITUDE DISTORTION.

When the grid voltage becomes less negative than -24 volts, after time c, the tube starts conducting, and the circuit again produces an output.

Between time c and time d, the circuit continues to operate without distortion. At time e, however, the output waveform is again distorted and remains distorted until time f. Let's see what happened.

Remember that every cathode is able to emit just so many electrons. When that maximum number is being emitted, the tube is said to be at SATURATION or PLATE SATURATION. Saturation is reached in a triode when the voltages on the grid and plate combine to draw all the electrons from the space charge.

Now, as our grid becomes less negative (between time c and time d), and actually becomes positive (between time d and time e), the plate current increases, the voltage across R_L increases, and the plate voltage decreases.

Apparently when the grid voltage reached +12 volts at time e, the plate current reached saturation. Maximum plate current (at saturation) results in maximum voltage across R_L and minimum plate voltage. Any grid voltage higher than +12 volts cannot cause further changes in the output. Therefore, between time e and time f, the plate voltage remains at +100 volts and the waveform is distorted. This is also AMPLITUDE DISTORTION.

This has been an explanation of one cycle of an input signal that overdrives the tube. You should notice that, using the same circuit, a 50-volt peak-to-peak input signal caused a vastly different output from that caused by the 6-volt peak-to-peak input signal. The 6-volt peak-to-peak signal did not overdrive the tube. When the input signal was increased to 50-volts peak-to-peak, the tube was forced into cutoff when the grid was driven to -24 volts, and into saturation when the grid was driven to +12 volts (the grid voltage plus the signal voltage.) During these periods, the tube could not respond to the input signal. In other words, the output was distorted. A method commonly used to partially overcome distortion is to vary the bias voltage on the grid. The point at which the tube goes into cutoff or saturation can then be controlled.

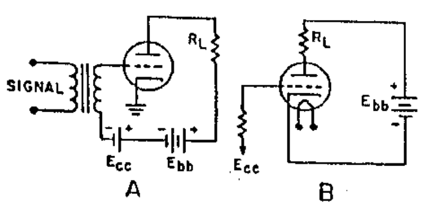
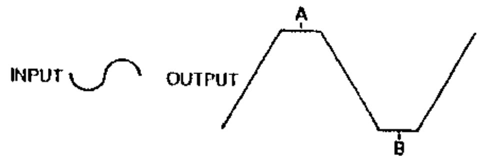


Figure 1-21.–Fixed bias: A. Battery; B. Conductor.

For this reason tube biasing is of great importance in most tube circuits.

Q20. The waveforms shown below are the input and output of an overdriven triode.



a. Distortion A at the output is the result of what condition?

b. Distortion B at the output is the result of what condition?

TYPES OF BIASING

There are two main classes of biasing-**FIXED** and **SELF**. In a tube circuit that uses fixed bias, the grid-bias voltage is supplied from a power source external to the circuit. You are already familiar with battery bias, which is one form of fixed bias. When fixed bias is used in a circuit, it can be represented as either a battery (fig. 1-21, view A), or as a conductor connected to $-E_{cc}$ (fig. 1-21, view B). Fixed bias is rarely used in electronics today. Therefore, we will not discuss it further.

In circuits using self-bias, the bias voltage is developed across a resistor in the cathode or grid circuit by tube current. There are two main methods of self-bias: *cathode biasing* and *grid-leak biasing*.

Cathode Bias

In circuits using cathode bias, *the cathode is made to go positive relative to the grid.* The effect of this is the same as making the grid negative relative to the cathode. Because the biasing resistor is in the cathode leg of the

ANSWERS TO QUESTIONS Q16. THROUGH Q19.

A16. To prevent them from drawing grid current.

A17. The input signal.

A18. +275 volts.

A19. a. 100 volts.
b. 180° out of phase.